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Priority Papers
6-17-03
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Edward Wechner	Attorney file:	5610
Serial No.:	10/050,679	Examiner:	ALI, HYDER
Filed:	01/15/2002	Group:	3747
For:	FREE-PISTON INTERNAL COMBUSTION ENGINE WITH VALVES LOCATED IN PISTONS		

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on June 9, 2003 by applicant's attorney, Carl L. Johnson.

Carl L. Johnson

June 9, 2003
Date

Honorable Commissioner for Patents
Alexandria, VA 22313-1450

Priority Document under 35 U.S.C. 119(b)

Sir:

Enclosed, please find a certified copy of a foreign application for which the above-identified application is claiming priority to under 35 U.S.C. 119(b). The enclosed foreign application, Australian Patent Serial No. 42050/01, was filed with the Australian Patent Office on May 4, 2001 and claims priority to Australian Provisional Patent Application No. PQ 8065, filed on June 9, 2000. Applicant submits that the enclosed priority document is being submitted with the Patent Office during the pendency of the above-identified application.

Respectfully submitted,
JACOBSON AND JOHNSON

By

Carl L. Johnson, Reg. No. 24,273
Attorneys for applicant
Suite 285
One West Water Street
St. Paul, MN 55107-2080

Phone: (651) 222-3775
Fax: (651) 222-3776

CLJ/cj
Enclosure

Patent Office
Canberra

I, JONNE YABSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PQ 8065 for a patent by EDWARD WECHNER as filed on 09 June 2000.

I further certify that pursuant to the provisions of Section 38(1) of the Patents Act 1990 a complete specification was filed on 04 May 2001 and it is an associated application to Provisional Application No. PQ 8065 and has been allocated No. 42050/01.

WITNESS my hand this
Twenty-first day of May 2003

JONNE YABSLEY
TEAM LEADER EXAMINATION
SUPPORT AND SALES

AUSTRALIA
Patents Act 1990

PROVISIONAL SPECIFICATION

IMPROVEMENTS TO FREE-PISTON ENGINES

The following statement is a full description of this invention, including the best method of performing it known to me:

IMPROVEMENTS TO FREE-PISTON ENGINES

This invention relates to free-piston internal combustion engines. More particularly although not exclusive, improvements to electric power generating free-piston internal combustion engines as described in references [1, 2, 3].

In prior art free-piston engines, the gas enters the combustion chamber via intake slots positioned in the cylindrical surface of the cylinder sleeve, similar to the method used on most conventional two stroke internal combustion engines.

The disadvantage of this gas intake arrangement is that the piston rings slide over the intake slots twice with each stroke. As the piston rings slide over the intake slots, the radial ring support area is reduced and a slight deformation of the ring occurs due to its elasticity and the radial piston ring forces (gas forces and ring pre-tension forces). This in turn accelerates the wear rate of the rings and the cylinder sleeve and is partly responsible for the fact that the two stroke internal combustion engine is no longer in use in modern passenger cars.

The objective of this invention is to ameliorate the aforementioned disadvantage and accordingly, a free-piston internal combustion engine is disclosed, having the intake valve located in the circular area of the piston head, similar to the valve-in-piston engine [4], thus providing an uninterrupted cylindrical surface for the piston rings to run on.

The currently preferred embodiment of this invention in the form of an electricity generating, homogeneous charge compression ignition (HCCI) [2,3] free-piston internal combustion engine will now be described with reference to the attached drawings, in which:

Figure 1 shows a cross-section of the engine along the center axis of the cylinders.

Figure 2 shows a section across the piston heat exchanger 14.

Figure 3 shows a section across the heat exchangers 23 and 24 in the permanent magnet linear actuator 7.

Referring to Figure 1, the main components of the engine are the cylinder blocks 1 and 2, the cylinder heads 3 and 4, pistons 5 and 6, linear actuator 7 and electricity generating stator 8.

As in prior art free-piston engines [1,2,3] the cylinders 1 and 2 fire alternatively in a two stroke cycle and convert the resulting alternating linear motion into electric energy. The main difference of this new invention is the method of charging the cylinders with fresh combustion gas.

Figure 1 shows piston 5 at the end of its expansion stroke, with both the inlet valve 9 and the exhaust valve 10 open for the two stroke gas exchange or scavenging process.

The intake gas was previously compressed during the expansion stroke of piston 5 in the linear actuator compression chamber 11 to a pressure that is capable of opening the inlet valve 9 against the opposing spring force 20 and the opposing kinetic force resulting from the retardation of the valve mass 9.

During the gas exchange process, the cool intake gas will pass through the linear actuator heat exchanger 23, the charge pipe 13, the piston heat exchanger 14 and the inlet valve 9 into the combustion chamber 15.

The incoming pressure of the fresh gas will assist the evacuation of the exhaust gas through the exhaust valve 10 and the exhaust port 32. The exhaust valve control solenoid 21 will open the exhaust valve 10 for a pre-defined but variable length of time to optimize the gas exchange efficiency for any given power consumption.

At low power consumption, only a small amount of exhaust gas will be evacuated, thus limiting the amount of fresh gas that will enter the combustion chamber 15 to the appropriate mass required to maintain the desired idling speed of the engine. This will release a minimum amount of pressure in the combustion chamber 15 during the gas exchange process and thus minimize the pumping losses.

At maximum power consumption, the exhaust valve 10 will stay open long enough to evacuate all the exhaust gas, allowing the maximum amount of fresh gas to enter the combustion chamber 15.

Similar to the valve-in-piston engine [4], the inlet valve 9 will be held closed by the gas forces in the combustion chamber 15 against the opposing kinetic forces resulting from the retardation of the valve mass 9 as the piston 5 approaches the ignition position during the compression stroke.

Piston 6 in Figure 1 is shown in the ignition position, having completed the compression stroke. During the compression stroke, fresh gas is sucked in by the linear actuator 7 through the air inlet 17, the air inlet ring chamber 18 and the ring valve 19 into the linear actuator compression chamber 12. The following expansion stroke of piston 6 will compress the fresh gas in the linear actuator compression chamber 12 ready for the next charge of combustion chamber 16.

The linear actuator 7 is equipped with gas seals 22 on both ends to act as a compressor piston for the gas exchange process, thus eliminating the need of an external intake gas charging device. In between the electricity generating stator 8 and the linear actuator 7 is a cylindrical sleeve 25 to provide a dynamic sealing surface for the gas seals 22. The cylindrical sleeve 25 must be of an electrically non-conductive, non-magnetic material and dimensionally thin, so not to adversely effect the efficiency of the electricity generating process. Suitable materials are either ceramics or high

temperature composite plastics that may be deposited on the surface or pressed into the bore of the electricity generating stator 8.

Other components of the currently preferred free-piston engine as shown on the drawings are identified as follows:

27 Cooling water jacket
28 Electricity generating coils
29 Electric power outlet junction box
30 Permanent magnets
31 Permanent magnet back iron

It will thus be appreciated that this invention, at least in the embodiment disclosed provides novel and unique improvements to free-piston engines. Clearly, however, the example disclosed is only the currently preferred form of this invention and a wide variety of modifications may be made which would be apparent to a person skilled in the art.

REFERENCES

1. Martin Goertz and Lixin Peng, Free Piston Engine Its Application and Optimization, SAE Paper 2000-01-0996, March 2000.

2. John DeGaspari, Cleaner Energy, mechanical engineering power, ASME May 2000.

3. Galileo Research, Inc., Free-Piston Engine-Generator Technology, www.galileoresearch.com, 1999.

4. Edward Wechner, Improvements in internal combustion engines, Australian Patent Application Number 63021/99 November 1999.

The claims defining the invention are as follows:

1. A free-piston internal combustion engine, having a piston pair 5 and 6 connected to each other and reciprocating in a two stroke combustion cycle, where the inlet valves 9 for each cylinder is located in the circular area of the piston head.

2. The free-piston engine as claimed in claim 1, having a linear electric power generating actuator 7 located in between the piston pair 5 and 6 that simultaneously acts as an intake gas charge compressor, where the left hand compressor chamber 11 charges the right hand combustion chamber 15 and the right hand compressor chamber 12 charges the left hand combustion chamber 16.

3. The free-piston engine as claimed in claim 2, where the fresh intake gas is pumped through the primary heat exchangers 23 or 24 located within the linear electric power generating actuator 7 and through the secondary heat exchangers 14 located within the pistons 5 and 6 of the said free-piston combustion engine.

Edward Wechner 6 June 2000

ABSTRACT

Improvements to Free-Piston Internal Combustion Engines are disclosed. The improvements consist of:

1) An alternative gas intake method where the inlet valve 9 is located in the cylindrical surface of the engines pistons 5 and 6, providing an uninterrupted cylindrical running surface for the piston rings 26 and increase the wear life of the piston rings 26 and the cylindrical surfaces of the combustion chambers 15 and 16.

2) A linear electric generating actuator 7 that is simultaneously used as a high pressure gas charging compressor, eliminating the need of an external charging device, where the left hand compressor 11 charges the right hand combustion chamber 15 and the right hand compressor 12 charging the left hand combustion chamber 16.

3) A heat exchange arrangement where the intake gas is pumped through primary convection heat exchangers 23 or 24 for the purpose of cooling the linear electric generating actuator 7 and through secondary convection heat exchangers 14 located in the pistons 5 and 6 to transfer the maximum amount of residual energy from the previous combustion into the fresh charge gas.

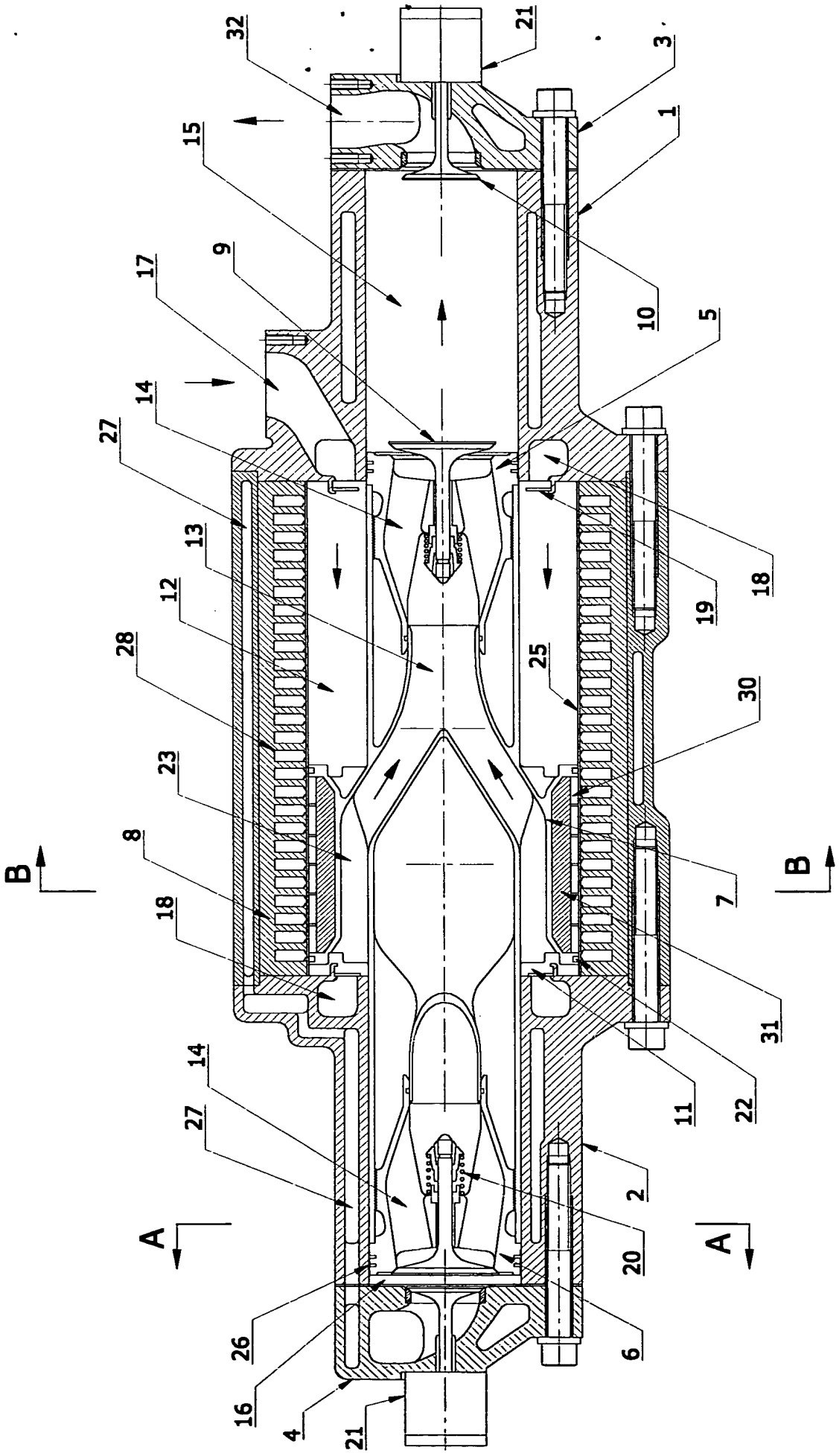
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Figure 1

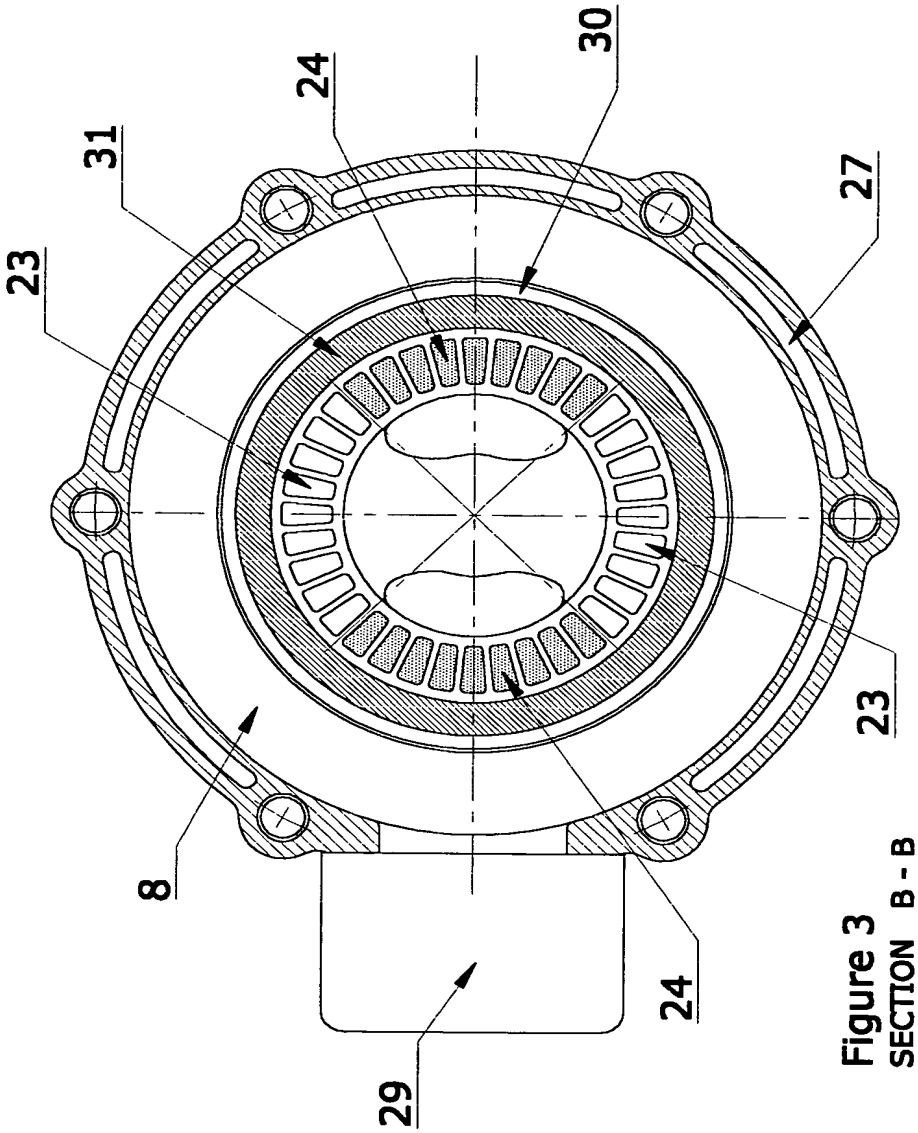

Figure 3
SECTION B - B

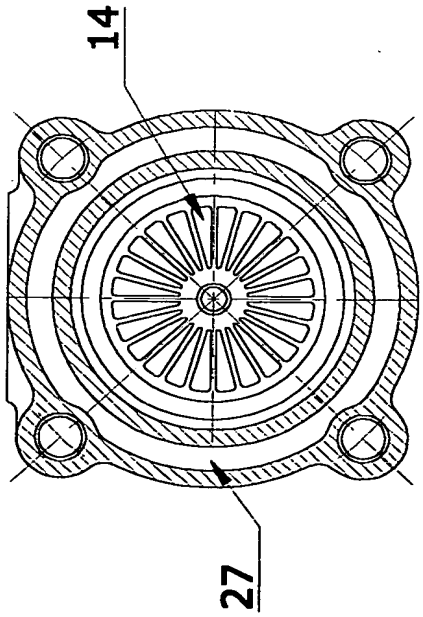

Figure 2
SECTION A - A